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Optical scanner and software therefor

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* בקשת חלוקה Application of Division		* בקשת פטנט מוסף Appl. for Patent of Addition		דרישת דין קדימה Priority Claim	
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For the Applicants. REINHOLD COHN AND PARTNERS By : _____				שנת of the year	1999

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סורק אופטי ותוכנה עבורו

Optical scanner and software therefor

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C.111546.8

OPTICAL SCANNER AND SOFTWARE THEREFOR

FIELD OF THE INVENTION

The present invention is in the field of text scanners and software for use therewith.

5 BACKGROUND OF THE INVENTION

Hand-held optical scanners are used in a variety of applications including text scanning, barcode reading, and picture grabbing. Image information obtained by the scanner is typically managed by a central processing unit (CPU) and stored in a memory. After processing, the
10 information is sent to a user application such as a word processor, database or spreadsheet.

In contrast to desktop scanners, the viewing area of hand-held scanners at a given instant includes only a small portion of the entire scanned medium. Thus in use, a hand-held scanner is made to pass over the entire scanned
15 medium so as to produce a time series of acquired images where each acquired image corresponds to a small portion of the scanned medium. One difficulty in the subsequent reconstruction of the scanned medium from the series of acquired images is due to variation in the scanning speed during scanning. Since the images are acquired at a constant rate, each location in
20 the scanned medium becomes, in the image, scaled in the scanning direction by a factor inversely proportional to the instantaneous scanning speed at that location. Locations in the scanned medium acquired when the scanning speed

is relatively low appear to be stretched or expanded, while locations acquired when the scanning speed is relatively high appear compressed. Hence, in order to reconstruct the scanned medium from the acquired images, each acquired image must be processed by rescaling it in the scanning direction by
5 a factor proportional to the instantaneous scanning speed. A hand-held scanner must therefore comprise means for continuously monitoring the scanning speed. U.S. Patent 5,083,218, for example, discloses a hand-held scanner comprising a wheel that rolls along the scanned medium during scanning for measuring the instantaneous speed at every moment during the
10 scanning. U.S. Patent 5,023,922 discloses a hand-held scanner with a 2-dimensional optical sensor in which the instantaneous speed is calculated from the time interval required for an image to traverse the sensor.

There is therefore a need in the art to provide a scanner that substantially reduces or overcomes the disadvantages of prior art scanners.

15

GLOSSARY

There follows a glossary of terms used in the following description and set of claims together with their definitions, some of them known in the art, others having been coined.

20

Field of view – the portion of the scanned medium acquired by a scanner at one instant.

Scanned image – a two-dimensional image created by moving a scanner over
25 a surface. The scanned image is compiled from the time series of fields of view acquired during scanning.

Text image – A scanned image composed of text.

30 *Cluster* – A contiguous group of black pixels in a text image. A black cluster is typically a single character but may be a portion of a single character, or a union of two or more characters.

Horizontal segment – A horizontal line of contiguous black pixels, one pixel wide. The length of a horizontal segment is the number of its black pixels.

5 *Stack* – A contiguous array of horizontal segments in a scanned image with the following properties:

- (a) The ratio of the longest horizontal segment in the stack to the shortest horizontal segment does not exceed a predetermined value.
- 10 (b) adjacent horizontal segments in the stack at least partially overlap (i. e. in a given pair of adjacent horizontal segments in the stack, there is a black pixel in each of the two horizontal segments acquired from the same field of view).

Each stack has associated with it a height (the number of its composite
15 horizontal segments) and a width (the average length of its horizontal composite segments). Each stack also has associated with it a bounding rectangle of minimum dimensions in which the sides are vertical and horizontal.

20 *Essentially vertical stack*– A stack in which the ratio of the vertical dimension of its bounding rectangle of minimum dimensions to the width of the stack does not exceed a predetermined value.

Character recognition software - Any software package for converting a text
25 image into a string of ASCII characters, for example Optical Recognition Software (OCR).

Stop interval– A series of consecutive fields of view that are not all white in a text image, in which the first and last fields of view comprise identical contiguous segments whose length exceeds a predetermined length.

Slow segment – a sequence of consecutive stop intervals in a text image.

Font ratio – the ratio of the mode character height (the most common character height) to the minimal vertical line width of the characters in a particular font. The font ratio is a characteristic constant of a given font.

5

BRIEF DESCRIPTION OF THE DRAWINGS:

In order to understand the invention and to see how it may be carried out in practice, a preferred embodiment will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in

10 which:

Fig. 1 shows a hand-held scanner according to the invention;

Fig. 2 shows a block diagram of the processing carried out according to the invention;

15 **Fig. 3** shows 7 characters resolved into 8 clusters;

Fig. 4 shows two clusters decomposed into horizontal segments;

Fig. 5a shows a line of text to be scanned;

Fig. 5b shows a text image obtained by scanning the line of text of Fig. 5a with a hand-held scanner; and

20 **Fig. 6** shows a flow chart for determining instantaneous scanning speed according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following description and set of claims, the direction of scanning by a hand held scanner is arbitrarily designated as the horizontal direction. This designation is being made only for the sake of simplicity in describing the invention. Other scanning directions are also contemplated within the scope of the invention and the invention is not to be considered as being bound by this arbitrary designation.

In its first aspect, the present invention provides a scanner having a one-dimensional optical sensor and not having mechanical moving parts such as a wheel. As shown in Fig. 1, the scanner, generally designated as 1, has a one-dimensional optical sensor 2, a handle 3 for grasping, and no mechanical moving parts. Scanned images are acquired by moving the sensor 2 over a surface. Fig. 2 is a block diagram of a system comprising a one-dimensional scanner and a processor according to the invention. The sensor 2 is used to scan a line of symbols. The sensor is linked to the input port 12 of a computer. The input function is managed by a CPU 14. Image information 16 obtained by sensor 10 may be stored by the CPU in a memory 18.

In its second aspect the present invention provides a method for determining the instantaneous scanning velocity during scanning by a hand held scanner. The method may be used with a scanner not having any mechanical moving parts. It may also be used with scanners having only a one-dimensional optical sensor. The method of the invention may be used for removing distortions due to variation in the scanning speed in the text image 16 acquired by the sensor 2 in order to make the text recognizable by character recognition software or by a user. The method, to be described below in detail, is carried out by an application 20 that processes the image either in real time or after being recalled from the memory 18. The results of the processing may optionally be processed by character recognition software before being returned to the CPU or sent to an active user interface 22.

The method of the invention is based upon the observation that in a scanned image, vertical distances (i.e. distances perpendicular to the scanning direction) at any particular location are independent of the

instantaneous scanning speed at that location. In particular, in a text image, the height of a text character is independent of the scanning speed. The mode character height in a text image is therefore independent of any variability in the scanning speed during acquisition of the text image. As disclosed below, the instantaneous scanning velocity at a location in a text image comprising an essentially vertical stack can be determined from the width of the essentially vertical stack, the mode character height of the scanned text, and the font ratio.

Referring now to Fig. 3, 7 characters are shown resolved into eight clusters. Clusters 1, 5 and 8 each form an entire character (e, c and e, respectively). Cluster 2 is a union of two characters (ff). Clusters 3, 4, 6 and 7 each contain a part of a character (i).

Fig. 4 shows two clusters divided into composite horizontal lines. In Fig. 4a, horizontal line 9, for example, has a length of 6 (pixels), and horizontal line 10 has a length of 8. Stack 12 has a height of 12. Two of the twelve horizontal lines constituting stack 12 designated as 15a and 15b have a length of 5, while the other ten have a length of 6. The width of stack 12 (the average length of its horizontal lines) is thus calculated to be 5.83. In Fig. 4b stack 13 has a height of 6 and a width of 27, which is equal to the cluster width. Stack 14 is composed of 13 horizontal line segments of lengths of 5-6. In this stack, there is no overlap between the lowest 16 and highest 17 horizontal line segments.

Fig. 5a shows a line of text to be scanned. Arrows 16 indicate the mode character height, and arrows 17 show the minimal vertical line width. The ratio of the mode character height 16 to the minimum vertical line width 17 (the font ratio) is a characteristic constant of the font.

Fig. 5b shows a typical text image obtained by scanning the text line in Fig. 5a with a hand-held scanner. The text appears distorted due to variation in the scanning speed. Character widths are inversely proportional to the scanning speed. As can be seen by comparing the width of characters 20 and 21 in the original text (Fig. 5a) with their images in the text scan (Fig 5b), interval 14 corresponds to a region of high scanning speed and

interval 15 corresponds to a region of low scanning speed. Vertical line widths, for example that of line 19, are also inversely proportional to the scanning speed. The mode character height 16, however, is unaffected by the variability in the scanning speed and is the same in Figs. 5a and 5b.

5 Horizontal line widths, for example that of line 18, are also unaffected by variations in scanning speed. Interval 22 is a typical slow segment.

Fig. 6 shows a flow chart describing the method of the invention for determining the instantaneous scanning speeds during acquisition of a text image such as the one shown in Fig. 5a. The mode height of the text
10 characters is determined 25, which, as stated above, is independent of any variability in the scanning speed. A first reference width is calculated 26 which is equal to the mode character height divided by the font ratio. Since the font ratio is defined as the ratio of the mode character height to the minimal vertical line width of the font, the first reference width is
15 substantially proportional to the proportionally correct minimal vertical line width of the text characters. All essentially vertical stacks in the text image are then identified 27 and their width determined 28. An essentially vertical stack is then found having minimal width among all essentially vertical stacks 29. A second reference line width is then calculated 30 equal to the
20 minimum of the first reference line width and the width of an essentially vertical stack of minimal width. The second reference width is substantially proportional to the proportionally correct minimal vertical line width. The instantaneous scanning speed at an acquired image comprising an essentially vertical stack is then 31 obtained by dividing the second
25 reference width by the width of the essentially vertical stack.

Referring still to Fig. 6, stop segments in the text image are processed as follows. Each stop segment is divided into a predetermined number of contiguous subsegments 32. In each subsegment, all of the images of consecutive fields of views are then deleted from the subsegment
30 except for the first and last images. The scanning speed in a slow segment is equal to the fraction of remaining fields of view after the aforementioned deletion of fields of view has been carried out 33.

Referring yet to Fig. 6, the instantaneous scanning speed at a location not comprising an essentially vertical stack and not comprising a slow segment that has been processed as above, is determined as follows. Two essentially vertical stacks are found such that the location not comprising an
5 essentially vertical stack is between them, and such that there are no essentially vertical stacks between them. The instantaneous scanning speed is then determined in the interval between the two essentially vertical stacks by interpolation of the scanning speed at the two essentially vertical stacks obtained as above 34.

10 Once the instantaneous scanning velocities during scanning of the text have been determined, the text image is rectified for distortions arising from variation in the scanning speed. This is accomplished by scaling each field of view in the scanning direction by a factor proportional to the scan speed, as is known *per se*.

15 In accordance with the present invention, the instantaneous scanning speeds during scanning of text, said text having a mode character height and a font, said font having a font ratio, is determined by a method comprising the following steps:

- a. determining the mode character height of the scanned text;
- 20 b. calculating a first reference line width by dividing the mode character height by the font ratio;
- c. determining the height and width of all essentially vertical stacks in the scanned image;
- d. finding an essentially vertical stack of minimum width;
- 25 e. calculating a second reference width equal to the minimum of the first reference width and the width of an essentially vertical stack of minimum width;
- f. calculating an instantaneous scanning speed for every essentially vertical stack by dividing the second reference width by the width of
30 an essentially vertical stack to obtain the instantaneous scanning speed at the essentially vertical stack;

- g. removing stop segments from the text image by a process comprising the following steps:
 - ga. dividing each stop segment into a predetermined number of contiguous subsegments of consecutive fields of view; and
 - 5 gb. deleting from each subsegment all of the images of consecutive fields of view except for the first and last images stack.
- h. calculating an instantaneous scanning speed for each stop segment as the fraction of images remaining after carrying out the deletion of images according to step g;
- 10 i. calculating the instantaneous scanning speed for every location in the image that does not comprise an essentially vertical stack and does not comprise a slow segment processed as stipulated in step g, by a process comprising for each such location, the following steps:
 - 15 ia. identifying a first and a second essentially vertical stack, such that said location is located between said first essentially vertical stack and said second essentially vertical stack and such that there are no essentially vertical stacks between said first essentially vertical stack and said second essentially vertical stack;
 - 20 ib. calculating the instantaneous scanning speed at said location by interpolation of the scanning speed at said first essentially vertical stack and said second essentially vertical stack.

While the above method has been described with a certain degree of
25 particularity, it will be immediately apparent to those versed in the art that the method may be varied without departing from the scope a spirit of the invention. In particular, the order in which the steps of the method may be carried out may be changed without departing from the scope of the invention as defined in the following claims.

CLAIMS:

1. A scanner for scanning a surface characterized in that it has a one-dimensional optical sensor and has no mechanical moving parts and.
- 5 2. A method for determining the instantaneous scanning speed during scanning of text, said text having a mode character height and a font, said font having a font ratio, comprising the steps of:
 - a. determining the mode character height of the scanned text;
 - b. calculating a first reference line width by dividing the mode character height by the font ratio;
 - 10 c. determining the height and width of all essentially vertical stacks in the scanned image;
 - d. finding an essentially vertical stack of minimum width;
 - e. calculating a second reference width equal to the minimum of the first reference width and the width of an essentially vertical stack of minimum width;
 - 15 f. calculating an instantaneous scanning speed for every essentially vertical stack by dividing the second reference width by the width of an essentially vertical stack to obtain the instantaneous scanning speed at the essentially vertical stack;
 - 20 g. removing stop segments from the text image by a process comprising the following steps:
 - ga. dividing each stop segment into a predetermined number of contiguous subsegments of consecutive fields of view; and
 - 25 gb. deleting from each subsegment all of the images of consecutive fields of view except for the first and last images stack.
 - h. calculating an instantaneous scanning speed for each stop segment as the fraction of images remaining after carrying out the deletion of images according to step g;
 - 30

- i. calculating the instantaneous scanning speed for every location in the image that does not comprise an essentially vertical stack and does not comprise a slow segment processed as stipulated in step g, by a process comprising for each such location, the following steps:
 - 5 ia. identifying a first and a second essentially vertical stack, such that said location is located between said first essentially vertical stack and said second essentially vertical stack and such that there are no essentially vertical stacks between said first essentially vertical stack and said second essentially vertical stack;
 - 10 ib. calculating the instantaneous scanning speed at said location by interpolation of the scanning speed at said first essentially vertical stack and said second essentially vertical stack.
3. A method for removing distortions in a text image due to variation in the scanning speed during scanning of the text comprising the steps of:
 - 15 a calculating the instantaneous scanning speed at every location in the text images by the method of Claim 2; and
 - b multiplying every acquired field of view in the text image by a factor proportional to the instantaneous scanning speed at the field of view.
- 20 4 The method of Claim 3 further comprising the step of processing the text image by character recognition software.
- 5 5 A scanner according to Claim 1 further comprising a CPU and software for carrying out the method according to any one of Claims 2 to 4.

25

For the Applicants,
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By:

Ben Spangin

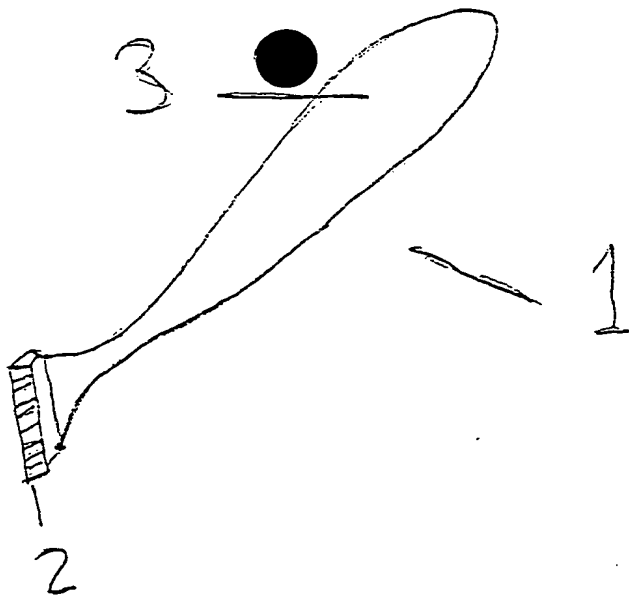


FIG 1

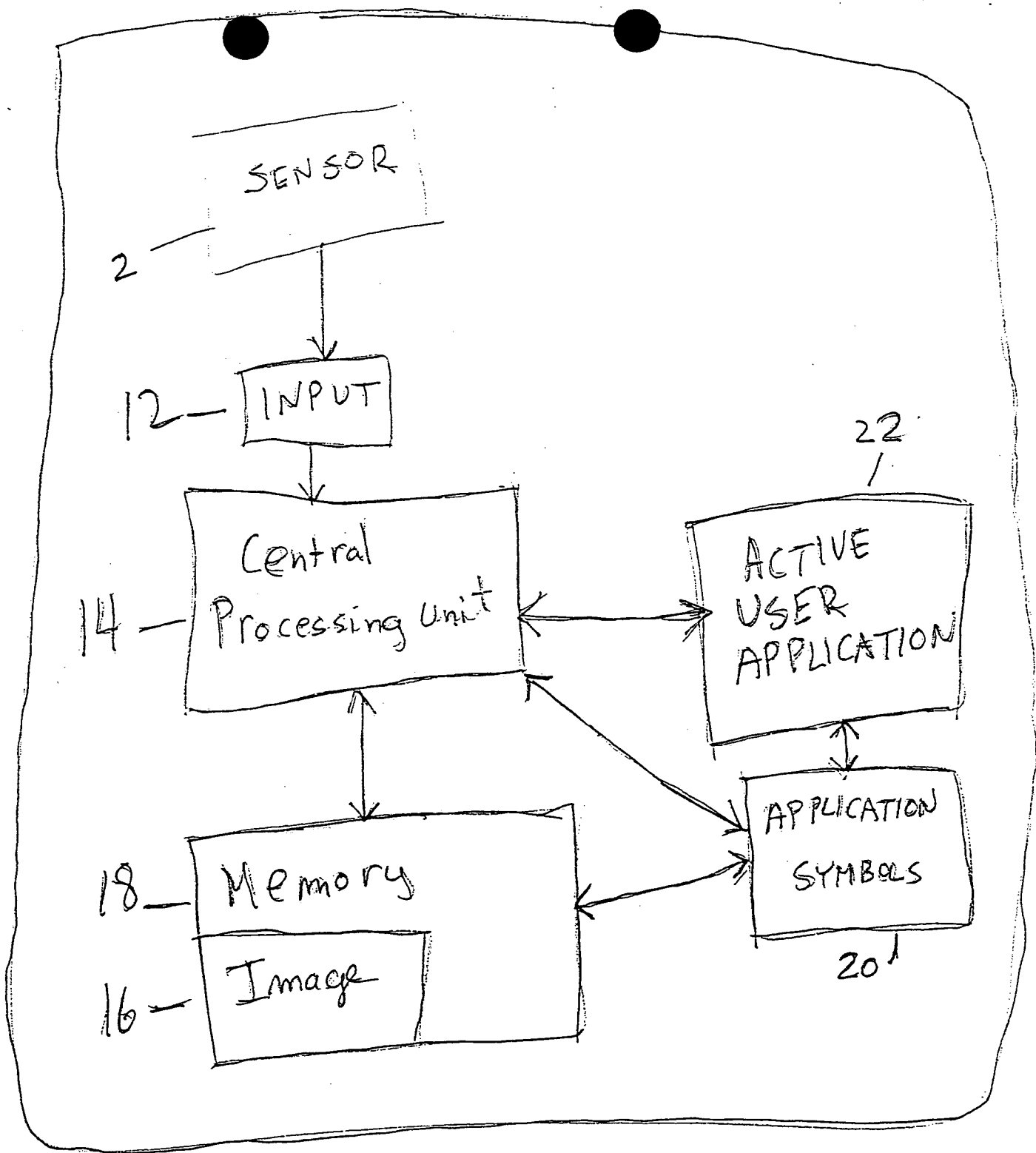


FIG-2

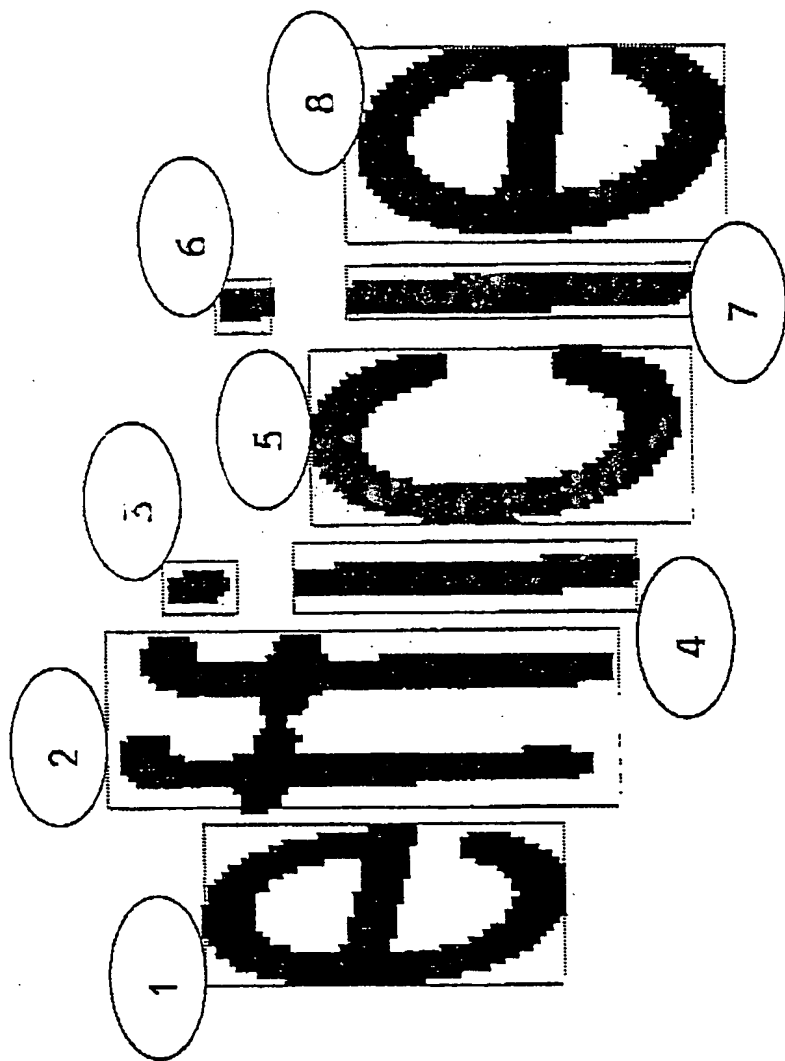


FIG. 3

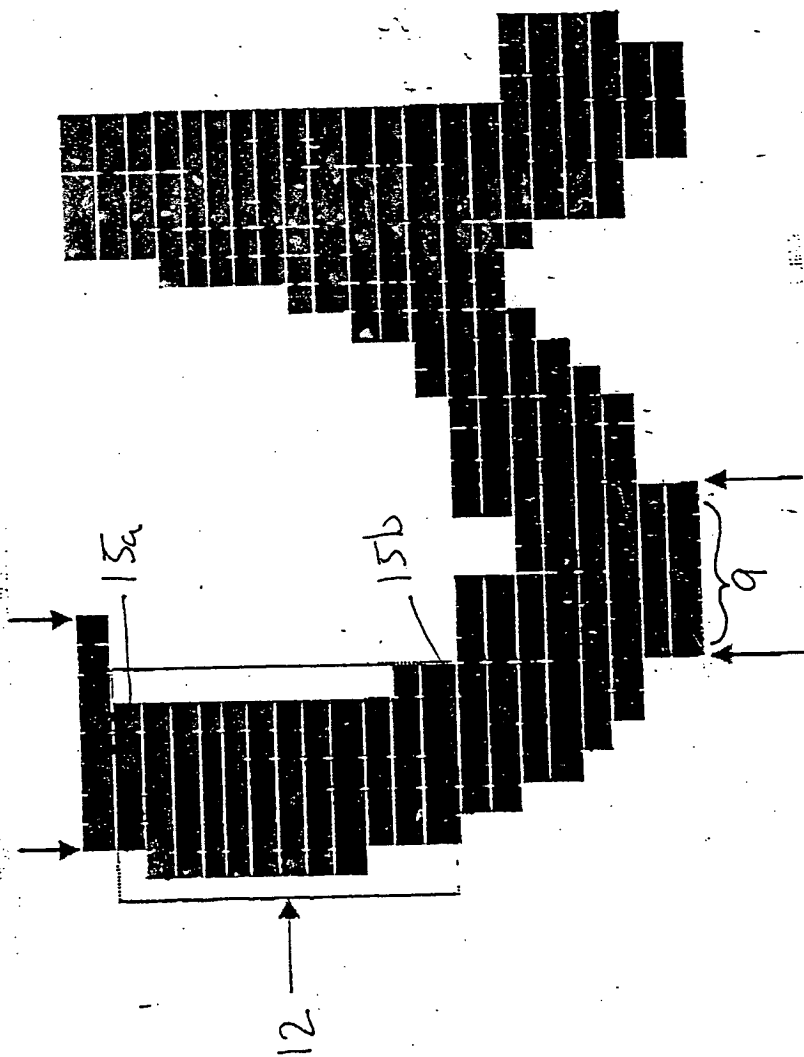


FIG. 4a

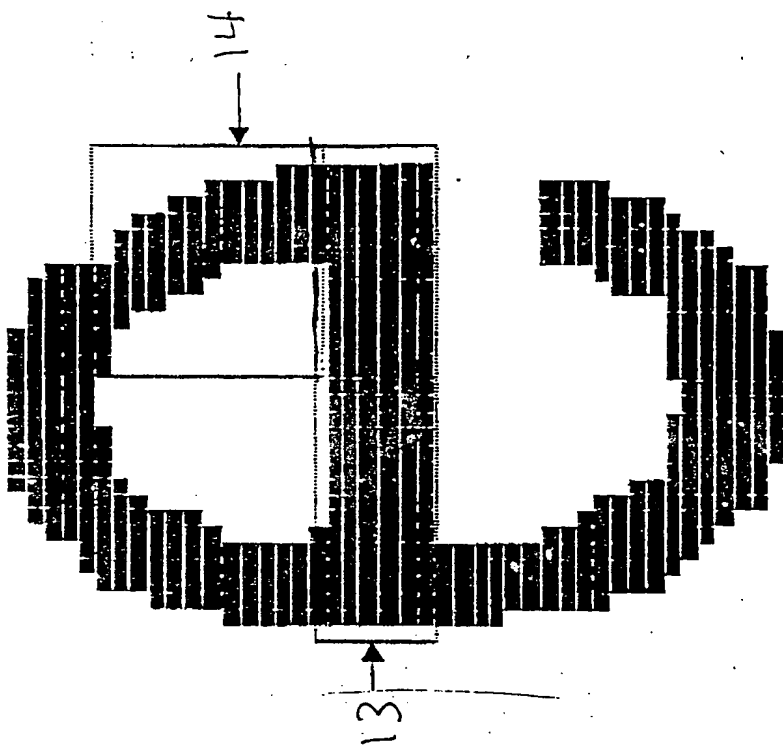
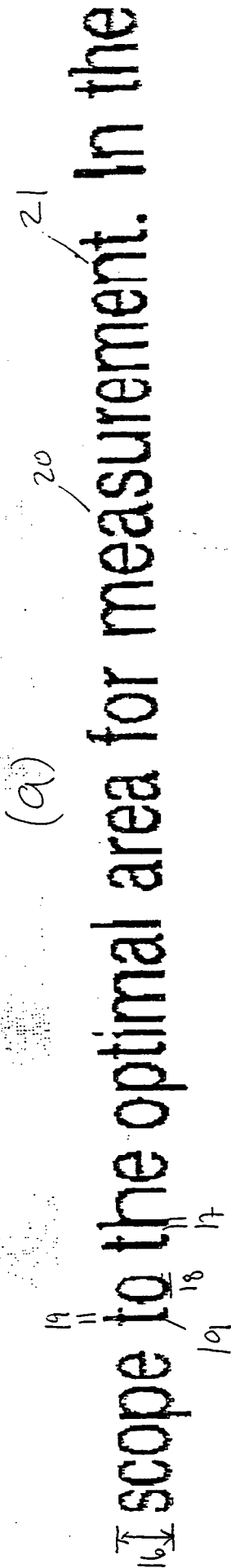


Fig. 4b

(a) 
 16 17 20 21

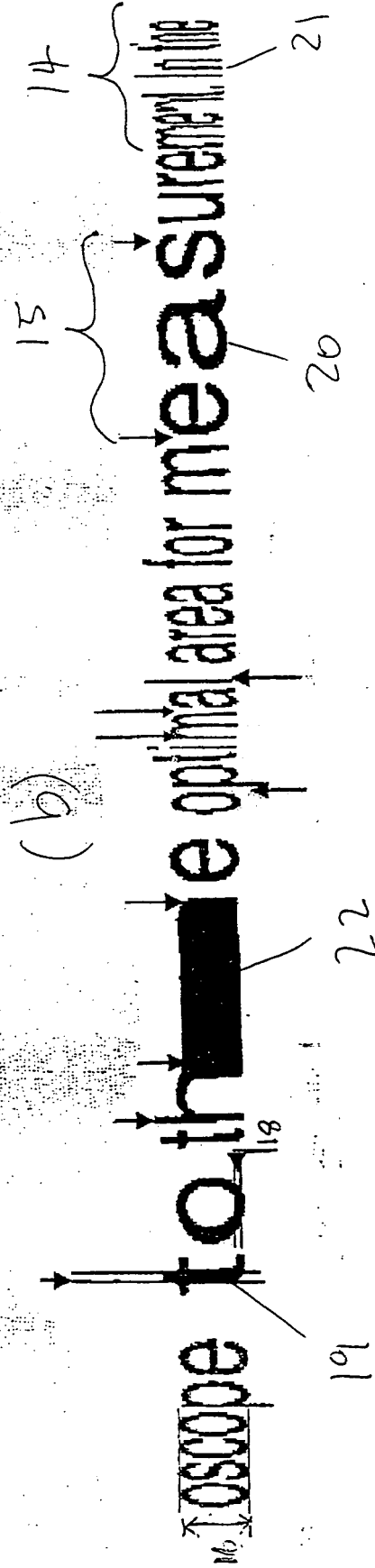
(b) 
 16 17 20 21

FIG. 5

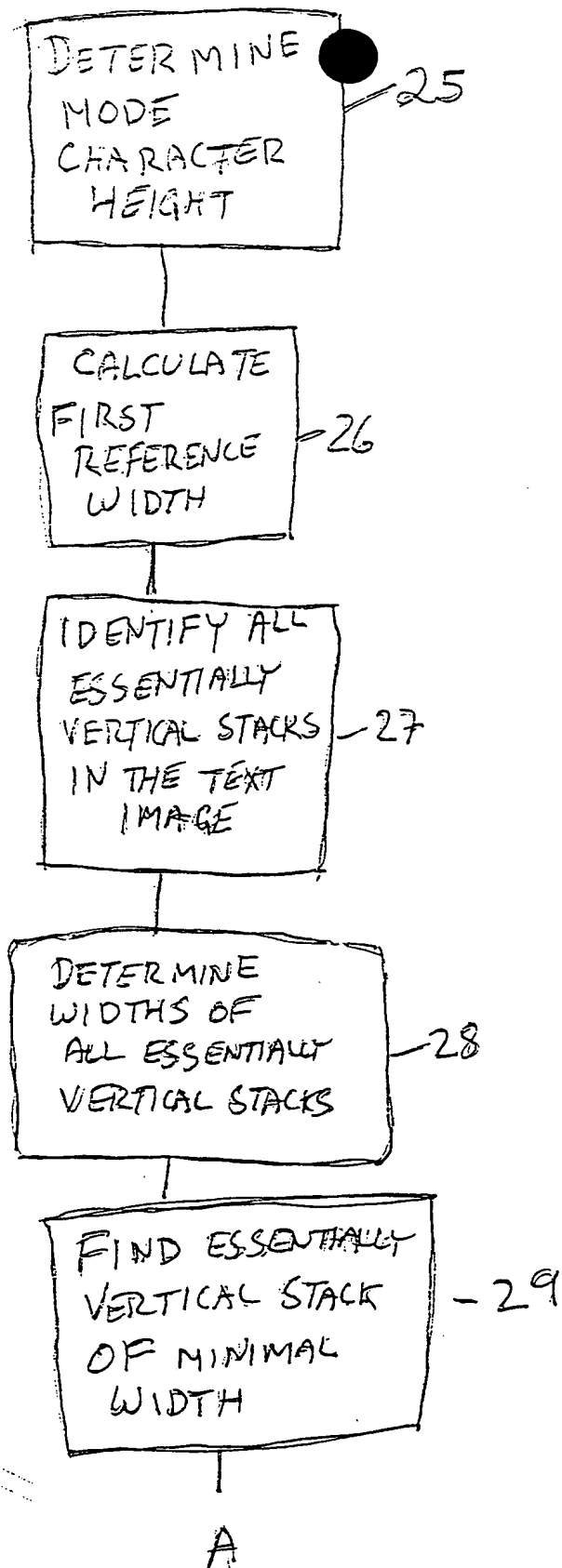


FIG 6

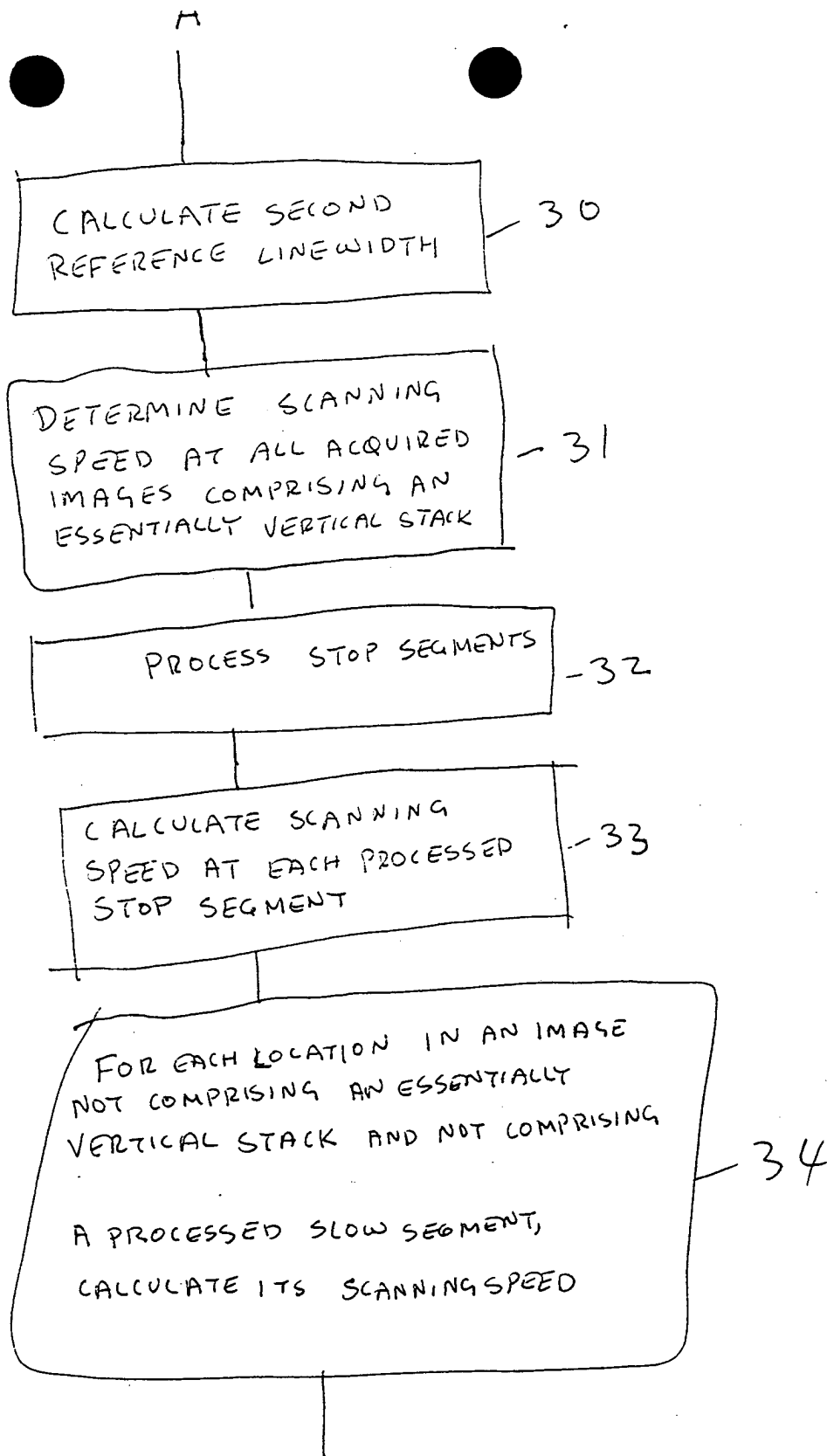


FIG. 6

1st CONTINUATION